ICE MAKING AND REFRIGERATION

HODGES AND HAVENSTRITE PATENTS

WESTINGHOUSE, CHURCH, KERR & Co

ENGINEERS.

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INTERNATIONAL

ICE-MAKING AND REFRIGERATING MACHINERY

MANUFACTURED UNDER THE

HODGES AND HAVENSTRITE PATENTS

BY

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A CARD.

WE DESIRE to announce that we have added to our business a department of Ice-making and Refrigerating Machinery. This department is distinct in its organization, having headquarters at our Boston Office, 620 Atlantic Avenue, under the immediate management of Mr. Church, with Mr. Fred'k E. Murphy in executive authority as Engineer in charge. Mr. Murphy brings to the business a wide practical experience from his connection with the Consolidated Ice Machine Company in its prosperous days, to which he has added an extended reputation gained as an expert in connection with the work of Prof. James E. Denton, of the Stevens Institute of Technology. We believe that our own standing in professional and financial responsibility, earned through eleven years of successful business, places us at once on a par with older competitors in this line.

In accordance with our usual practice, we shall in the near future issue explanatory printed matter which will make clear to the intending purchaser the mechanical principles involved in the production of artificial cold — our policy being to discuss the fundamental engineering of every problem in such a way as to make it thoroughly apprehended by the reader, thus bringing his own judgment to bear upon the soundness of our practice. This matter is now in hand, but the preparation of the requisite engravings is necessarily a work of time. We, therefore, offer the following pages merely as advance sheets, describing the special apparatus which we manufacture in so far only as it is distinctive.

The production of artificial cold and its utilization in an increasing variety of industries has received the attention of the best mechanical ability for the past twenty years. Various experimental stages involving the use of air, ether, sulphur-dioxide, etc., have led to the universal adoption throughout this country and Europe (with one possible exception), of liquified anhydrous ammonia as the refrigerating medium. In the use of ammonia two distinct systems have been exploited, known respectively as the Compression and the Absorption systems. In a treatise now in preparation, we shall make clear the characteristics of each system and the limitation of their application. The greatly preponderating majority of plants are constructed upon the Compression system, the advantages of which, briefly stated, are a much higher efficiency in the use of coal and water per unit of work done; greater reliability of action, and a simple form of apparatus easily within the comprehension of the owner.

For some time past we have been led to believe that there were immense possibilities in the application of artificial cold, which had not been, and which could not be met by any form of apparatus now on the market. This is in no sense decrying other builders of either system, as too much recognition cannot be given to the intelligence with which both have been worked out. Absorption apparatus being limited in its range and efficiency, and so far as the user is concerned, vague and treacherous in its operation, has not secured a large place in the market, deriving its business mostly from its somewhat lower first cost as compared with heretofore existing com-

pression systems. The various forms of compression apparatus offered by their several builders are nevertheless almost identical in construction, and wholly so in principle. It is an expensive class of machinery, and the fact that its cost does not decrease in proportion as the size of the plant decreases, has limited its application mostly to heavy industries employing large capital, such as breweries, cold-storage warehouses, ice-making plants of fifty tons capacity and upwards in the larger cities, etc. The fact impressed us, that if a compression system could be designed in which, without sacrifice of its normal efficiency, the apparatus itself could be so simplified as to reduce its first cost, and especially to keep that cost practically pro-rata with its capacity in plants of small and medium size, a field of wide application would be opened up in many industries thus far unconsidered. The problem attracted us, being closely allied to the lines of steam engineering on which we have developed an extended and successful practice.

Having a clear idea as to the essential points of an apparatus to meet these commercial requirements, we interested ourselves in 1889 in a form of compressor then being designed, and since patented by Horace F. Hodges and David J. Havenstrite, of Boston. The outcome of their work has been a compressor and condenser containing exactly the features necessary to the successful development of the business which we proposed, and negotiations were early commenced looking towards a connection with them. These negotiations have now culminated in the form of an Exclusive License under which we control the manufacture and sale of this apparatus with all future improvements. On and after this date (April 20th, 1893), we therefore succeed Messrs. Hodges & Havenstrite, and their successors the Standard Refrigerating Company, in the further conduction and development of the business. It is hardly necessary to state that we shall bring into it the high-class engineering and general reputation for good work with which we have come to be credited.

ARTIFICIAL COLD.

VERY briefly, the cycle of operation in the production of artificial cold commences with the expansion into a gas, of a liquid having a low boiling point. The process is precisely analogous, except as to its position on the scale of temperature, to the expansion or evaporation of water by boiling. Water boils at a temperature of 212° at atmospheric pressure This temperature being higher than that of natural objects, artificial heat has to be supplied by the combustion of fuel in order that the water shall be allowed to boil, or in other words, to expand. In this sense the water in expanding may be said to cool the fire. We ordinarily conceive of the process as being for the purpose of boiling the water into steam. It would be equally scientific to reverse the thought, and consider the evaporation of water as a means for abstracting heat from a body of higher temperature, as for instance from a fire. (The slow evaporation of water from the hand produces a cooling sensation, which is perhaps a still better illustration.) This leads to a conception of refrigeration as a process by which the expansion or boiling of a liquid having a low boiling temperature is made to abstract heat from any contiguous body having a relatively higher temperature. The most convenient liquid is found to be anhydrous ammonia, having a boiling point 28½° below zero under atmospheric pressure, and which in boiling will therefore abstract from any contiguous body having a natural temperature the heat necessary for its expansion into a gas.

The cycle of operation, as has been stated, commences at the expansion valve through which liquid ammonia is allowed to slowly feed into a coil of pipe, where it boils away into a gas, rapidly abstracting heat from all surrounding objects. To render the cooling effect available, the coils of pipe into which the ammonia expands may be submerged in a tank containing a saturated solution of common salt. This brine is speedily reduced to any desired temperature down to zero, and thus becomes a storehouse of cold, so to speak, which can be drawn upon by circulation through other coils of pipes running through cooling rooms in the case of refrigeration; or cans of water may be submerged in the brine in the manufacture of artificial ice. The better method of refrigeration is more often the direct expansion of the liquid ammonia into the coils in the cooling room, but in either case the underlying principle of the absorption of heat is precisely the same.

Typically, the above is a complete refrigerating apparatus, but it is evident that with the elementary process described, the ammonia gas, having been expanded, will escape into the air and be lost. The waste of ammonia, and the absence of any means of continuous operation therefore demand some way of recovering and re-liquifying the ammonia after it has done its work. Such apparatus is most conveniently a simple pump, which is but another name for the more common term of "compressor." The suction side of this pump is connected to the coils into which the gas has been expanded. The first operation of the pump is to draw from these coils at each stroke a certain portion of the expanded gas.

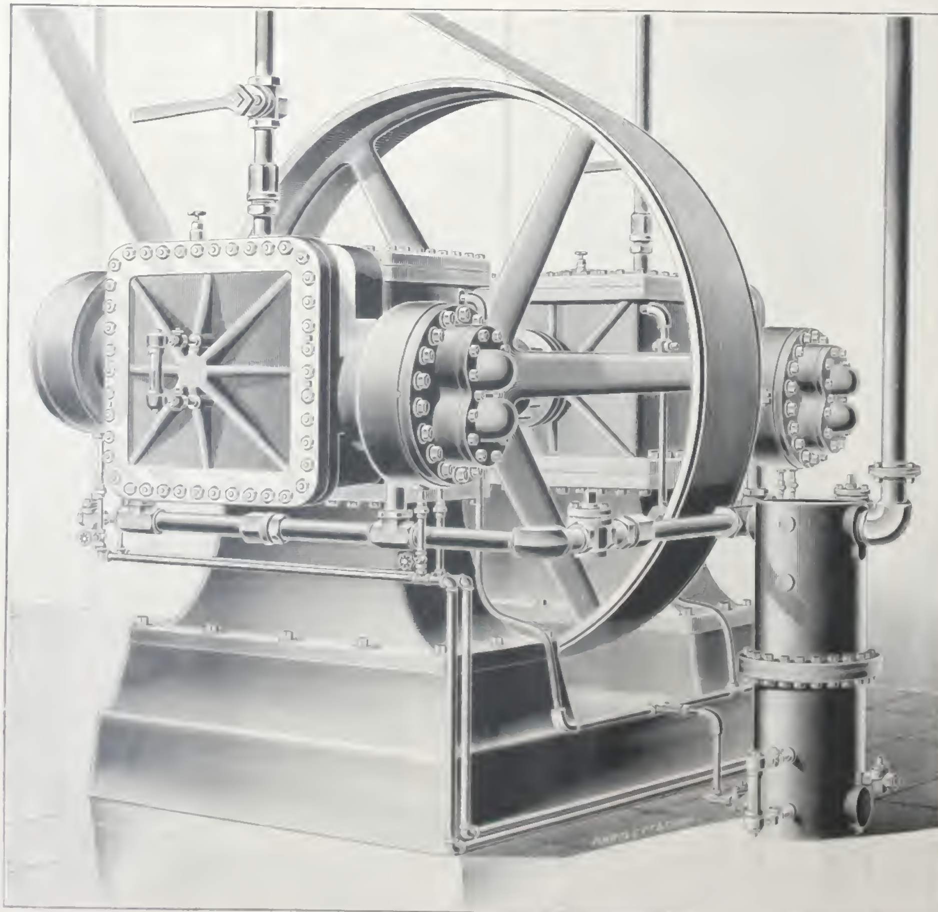
Again, since it will be readily seen that by adjusting the supply of liquid ammonia into the coils in proportion to the volume of the gas pumped from the coils, the pressure in the expansion coils may be maintained at any desired point,—and because the boiling temperature of the ammonia depends upon this pressure, it is obvious that we have a convenient means of controlling the temperature of the coils, and thereby the degree of refrigeration as well.

The gas being drawn into the pump through the suction valves, is, so to say, the ammonia vapor compressed or squeezed up to a pressure at which it would liquefy, were it not for the fact that in the act of compression it is heated to a high temperature. It now follows that means must be provided for cooling the gas as soon as it escapes through the delivery valve from the compressor. To this end a surface condenser of some form is provided, consisting generally of a coil into which the discharge pipe from the compressor connects. The condenser coils may be either submerged in a tank of water or may be kept cool by water running over them. The minor differences of [illegible] in the use of these depend upon the form of the condenser, as will be seen hereafter.

The hot compressed gas from the compressor is thrown against the cool surface of the condenser and [illegible] its warmth [illegible] its original condition of a liquid. From the condenser it then runs back to [illegible] receiver and is ready to [illegible] anew the cycle of operation in the expansion coils where it [illegible] the [illegible] of the process.

The above process is [illegible] [illegible] [illegible] [illegible] [illegible] producing artificial cold by compression, so called. The differences between the [illegible] apparatus [illegible] [illegible] by [illegible] [illegible] are so [illegible] [illegible] [illegible] [illegible] to be indistinguishable, and are in fact wholly [illegible] so far as the user is concerned.

With this very brief outline of the refrigerating process we pass to the description of the [illegible] [illegible] of [illegible] in [illegible] [illegible].



INDEPENDENT COMPRESSOR.

THE COMPRESSOR

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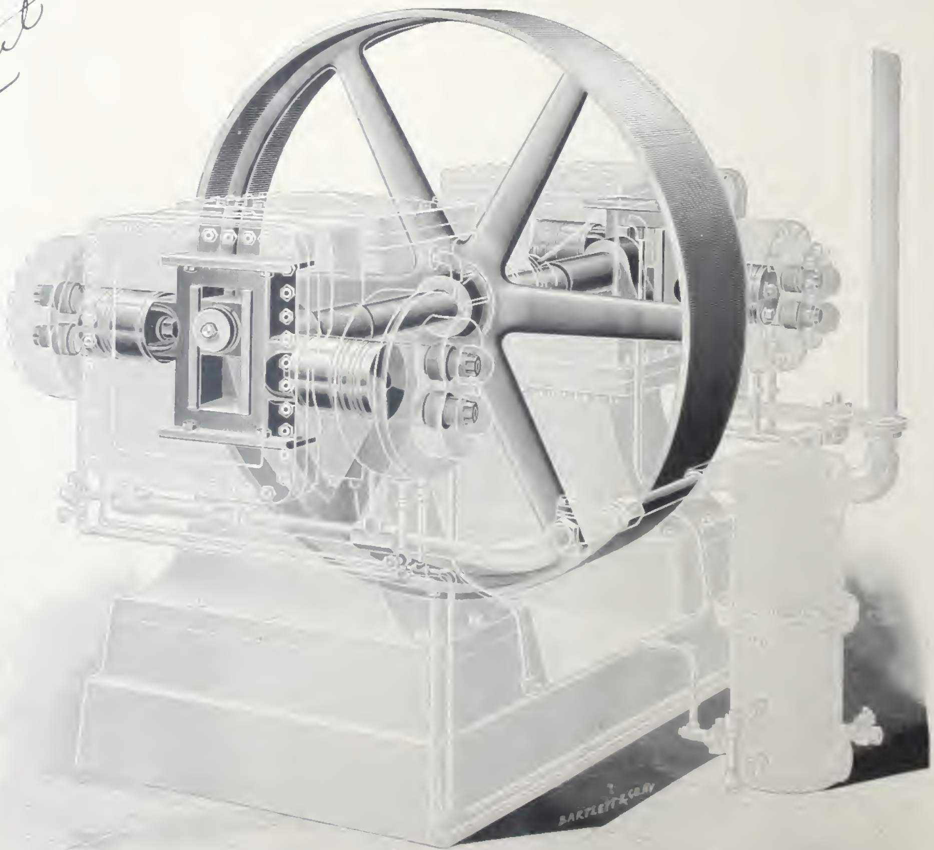


WORKING PARTS OF COMPRESSOR

with, and the compressor is reduced to a compact, stiff and accessible machine, eminently adapted to the severe work imposed upon it.

A heavy steel shaft enters both crank chambers through stuffing boxes to prevent leakage of oil. On each end of the crank shaft inside the crank chamber is a removable steel crank disc, the extended sleeve of which forms a large bearing surface, running in cast iron removable boxes. The use of composition metals containing copper is not admissible with ammonia.

The crank pin is of special construction, being built up of a pin carrying a hardened steel sleeve held in place by a collar. This sleeve has two key-ways on opposite sides enabling it to be reversed on the pin. The cylinders being single acting, all the wear falls on one side of the sleeve, so that when unduly worn it may be turned side for side and a new bearing surface secured.

Motion is transmitted to the pistons through a massive yoke onto opposite sides of which the pistons are directly bolted. Adjustable gibs on the top and bottom of the yoke carry its weight and side thrust, thereby relieving the cylinders entirely. Similar gibs on the inside of the yoke take the wear of the sliding block.

All the parts on which wear can come are of the simplest construction, and can be thrown away and replaced at trifling expense when worn. But the crank chamber is filled with oil, the height of which can be seen in the gauge glass in the bonnet plate, and as all the working parts revolve in oil on extraordinarily large bearing surfaces, it follows that the wear is minimized to the utmost. We recently inspected a compressor which had been in operation continuously for three years, and found the tool marks scarcely beginning to show signs of wear. The cylinders themselves are removable bushings forced into a heavy casting so that when worn they can be replaced at insignificant cost. The crank sleeve which forms the main bearing can also be replaced when worn.

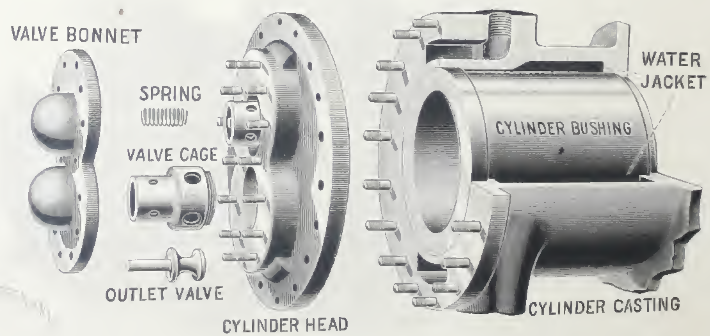
The pistons are merely plain hollow heads bolted hard against the yoke and packed with a number of light rings sprung into grooves. Such a packing not only proves to be the most efficient against highly compressed gas, but makes the cost of repairs nominal. By this system of cheap interchangeable wearing parts the compressor can be maintained literally "as good as new" after an indefinite term of years.

Access is conveniently had to the main bearings in the chamber by removing the top bonnet, and to the yoke and crank by removing the front bonnet.

It will be interesting to note that the two cylinders of each crank chamber are not in line with each other, but are placed respectively above and below the center line by a distance equal to one-half the crank radius. The effect of this is to improve the angle of thrust of the crank as the resistance of compression increases towards the end of the stroke. To the excellence of this feature much of the good working of the compressor is due.

The cylinder head is a heavy casting, chambered for the inlet and delivery ports with their respective valves. These last with their seats are of Bessemer steel, ground tight and finished flush with the inner face of the cylinder head.

The solid connection of the pistons and yoke without intermediate pins or brasses provides that the total distance



DETAILS OF CYLINDER AND VALVES.

from head to head of the pistons, plus the stroke, can be made and kept exactly equal to the length from flange to flange of the cylinders. The clearance space upon which the efficiency of the compressor so largely depends is not only reduced to $\frac{1}{64}$th, as nearly equal to zero as mechanical construction can make it, but maintains itself naturally without suffering from increase of clearance due to wear.

Both valves are covered by removable caps so that the valve and valve seat are readily accessible. The valves are checked by light springs just sufficient to keep them from chattering, and all the valve mechanism can be replaced in case of wear or breakage in a few minutes.

The whole surface of the cylinder is water-jacketed by circulation through the space between the bushing and the outer casting. The heat of compression is thus partially absorbed, and the cylinder casting kept free from distortion due to unequal expansion.

It will be noted that the compressor being duplex, and each side carrying two cylinders, it becomes possible to nearly equalize the rotative effort by placing the two cranks at right angles, whereby the four resisting strains are equally distributed through each revolution. This enables belt transmission to be employed, whereas the use of a belt has heretofore been impossible.

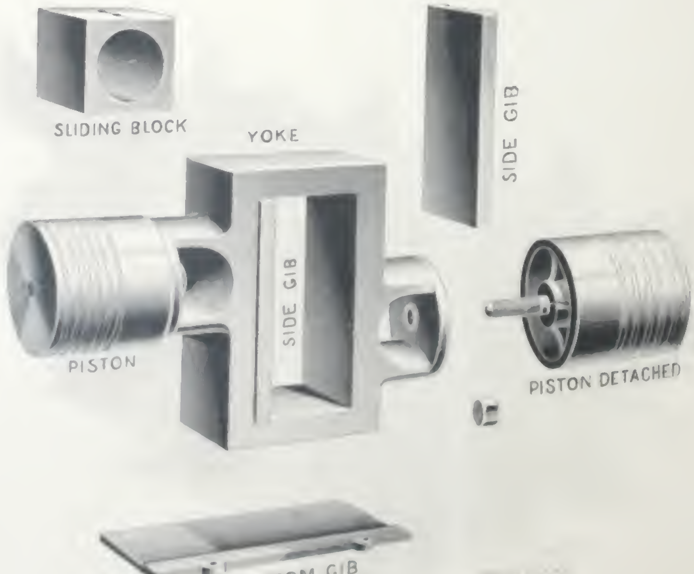
The whole construction of this compressor is of the most massive and compact character. This is apparent even from the engraving, and doubly so from the inspection of the machine itself. It is impossible to over-state the smoothness of its operation. Instead of two massive fly wheels grinding in their bearings we employ an ordinary split pulley without any extra rim weight. No surge of the belt is visible under any pressures, and the whole machine runs with almost perfect noiselessness, the only sound detected being the faint click of the valve as it seats. A 30 ton compressor can be turned over by hand with ease by one man at the rim of the pulley. The pulley having no appreciable momentum, it follows that the chance of a wreck from some obstruction in the cylinder largely disappears, as the belt merely slips off from the pulley, thus acting as a safety check of a thoroughly practical kind.

It will be evident from the description how completely this compressor meets the objections found to obtain in the other forms already cited.

Since it may be driven from any source of power, not requiring a special direct-connected engine as a part of the machine, one or more compressors may take power from a single compound condensing engine or from independent compound engines by direct belting, whenever the prime use of steam in the engine itself is to be reduced to a minimum, as is the case in refrigeration. The friction of the machine itself is extraordinarily small as compared with other forms of compressor, and the user may avail himself of every device known to steam engineering to secure the highest fuel economy.

In an ice making plant, where the exhaust is utilized in other parts of the process, a plain non-compound engine will be employed, and first cost thereby considered.

It will happen in very many cases, particularly in small refrigerating plants, that the customer has general power on a shaft or electric power-circuit at his command, and he will therefore utilize this power through a belt or a motor without



DETAILS OF YOKE AND PISTONS

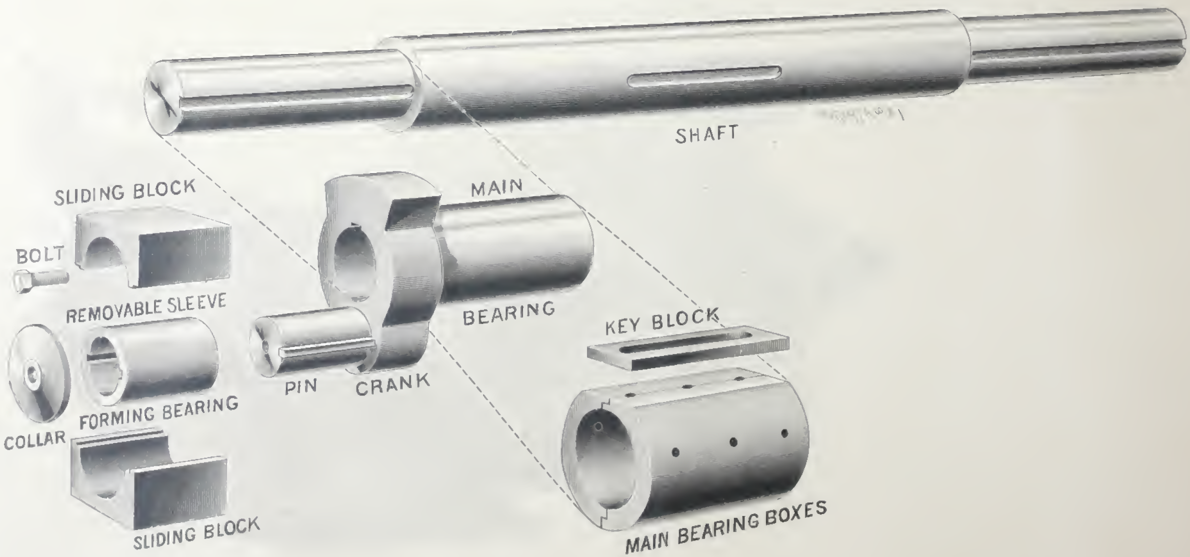
being compelled to purchase an additional engine as a necessary part of the compressor. This feature alone introduced this type of apparatus to a wide market among industries requiring small local refrigeration.

The important principle of sub-division of units which has made for itself a fixed place in many departments of steam engineering, is now for the first time applied in its full value to refrigeration. Instead of a single unit—for illustration, say, of 60 tons—we may employ two units of 30 tons, three units of 20 tons or four units of 15 tons, just as the best consideration of local conditions may demand, and this without increase but rather with actual decrease of first cost. It is at once seen that the risk of loss by stoppage is sub-divided in proportion to the number of units. In important direct-expansion plants where stoppage must be avoided at all hazards a spare unit is installed ready for immediate service whenever required, and at comparatively trifling expense. Even in small plants using a single compressor it may be run to half capacity on one side, while the other side is disconnected and overhauled.

Still more important is the effect of the sub-division of units on the efficiency of the plant under variable service. Many and indeed most plants for artificial refrigeration, and for that matter for ice-making as well, vary in their required capacity between very wide limits, according to the season of the year. In some kinds of service the capacity may even vary from day to day. By subdividing the units the initial capacity of the plant is made to keep pace with the fluctuating requirements, with no more trouble than is involved in the shifting of a clutch or the stopping of an engine. In one cold-storage plant, which we are at this moment designing, five 35 ton units will be employed, of which four will perform the maximum summer service, one standing as a relay. It is expected that a single machine, or at most two out of the five, will take care of the winter service. By this means the efficiency of the compressor, equally with the steam efficiency of the engine which drives it, and of the boilers which supply it, is always at the maximum in accordance with the well known principle that under-load is one of the most wasteful and inevitable sources of loss in the generation or application of power.

The saving of space by a plant of this character, both in head room and floor dimensions, is obvious. To illustrate: the 35 ton compressor occupies a floor space 7' x 11', and is 8' 9" high over all. Advantage is often taken of this to erect the apparatus in a basement or sub-basement, leaving the receiving or working floors of the buildings unobstructed.

The sub-division of units also implies practical flexibility as to enlargement. It is seldom that a manufacturer can forecast his requirements in any department, and particularly in that case of refrigeration. If he is compelled to purchase his whole capacity in a single unit, it may prove to be too large and be wasteful in economy, or as his business increases it will soon come to be too small, in which case the remedy is found only in a disproportionate additional expenditure. By the employment of sub-divided units the manufacturer may install with reference to his immediate and definitely known capacity, with the certainty that he can increase from time to time, at a cost which is strictly proportionate to the increase of his requirements. This feature is of large importance in almost any industry employing refrigeration, but it particularly so in the manufacture of artificial ice, in which the ultimate growth of the demand is an almost indeterminate quantity.



DETAILS OF CRANK AND SHAFT.

The mechanical excellence of the compressor itself, as regards its simplicity, smoothness of operation, cheapness and ready renewal of wearing parts, etc., has already been made apparent from the description. It will be greatly to the advantage of any intending investor to examine the machine in detail and in operation if convenient to do so, since we observe that the compressor urges its own claims much better than can be done by any statement of its builders.

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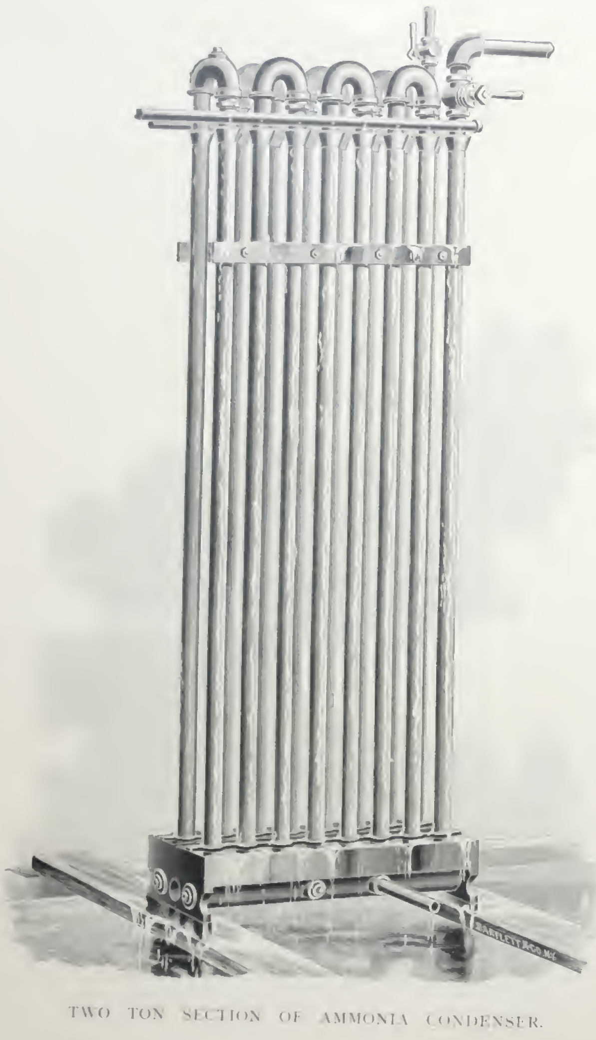


TWO TON SECTION OF AMMONIA CONDENSER.

THE CONDENSER.

EQUALLY with the compressor, the condenser herewith illustrated as a part of this system, shows evidence of a thorough understanding of the problem involved. Passing the submerged condenser, which is a form seldom used except with sea water, we find that the form commonly employed is in the shape of horizontal coils of pipes, arranged as a flattened helix, the individual pipes being practically horizontal. Water is led on to the top pipe and spatters down over the coils, falling from pipe to pipe in its progress. A large percentage of the water is thrown off mechanically before accomplishing its work, and attempts have been made to check this waste by some form of guide fin between the pipes. The flow of water being rapid and the waste quite disproportionate, an undue volume is required which is often a serious rebate upon the capacity of the plant. It is not infrequently found that the problem of water and not of coal is the controlling factor in the operation of a refrigerating plant.

Furthermore, the coils ordinarily used are continuous with welded joints. This makes them expensive in first cost, expensive to repair, expensive to increase, and without flexibility as to relative capacity under variable loads; in all these respects resembling the single unit compressor.

The form of condenser which we illustrate has very distinct merit. In the first place it is built in sections, each section representing a capacity of one ton. The sections are strictly uniform and duplicate, no matter what the size of the plant, so that they can be made and carried in stock. When a contract is taken it is only necessary to ship the number of sections corresponding to the required capacity, place in position and bolt together.

If the plant requires enlargement more sections are added.

If any section becomes disabled it can be taken out and replaced by a new one without loss of time.

If the work varies with the season any number of sections can be temporarily cut out of service, and water used only upon those which are in operation.

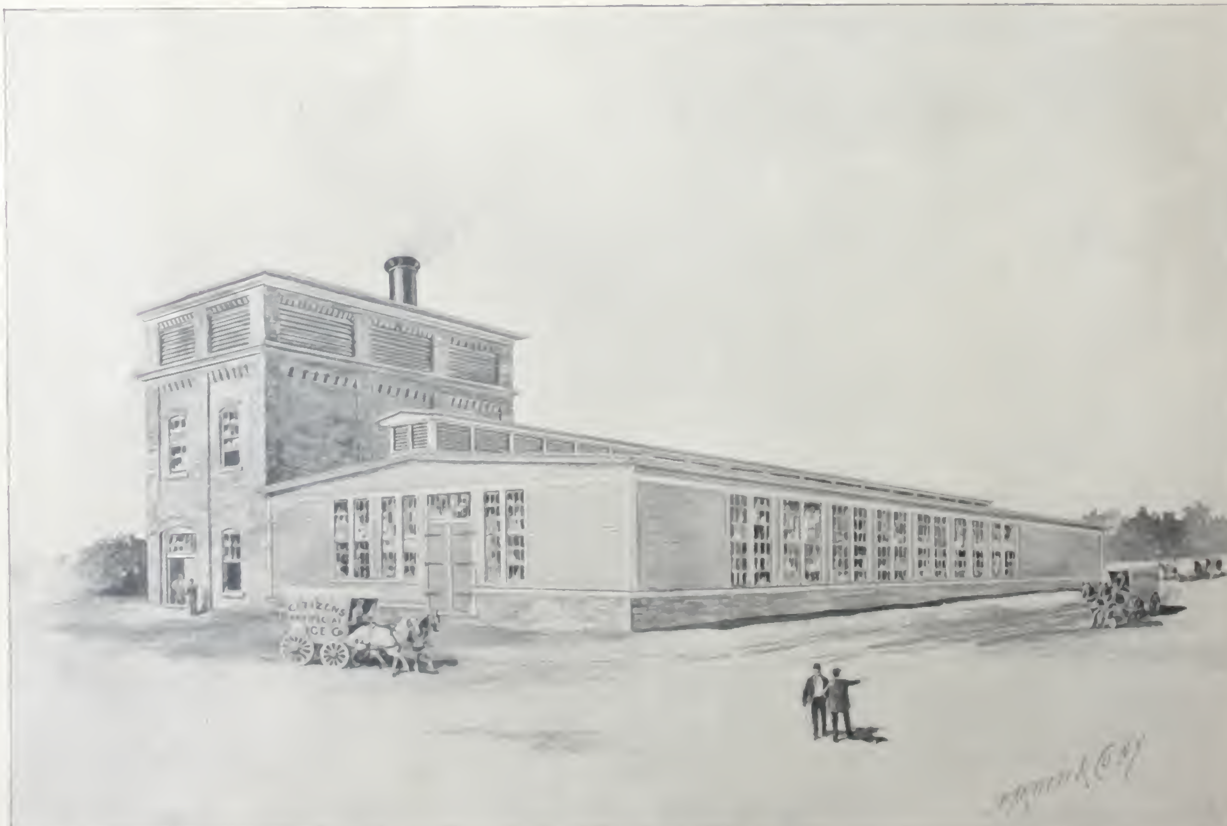
All the advantages of sub-division repeat themselves in this condenser much as in the compressor, and at correspondingly small expense.

This condenser has the collateral advantage of occupying less than one-fifth the floor space of any other condenser of equal capacity. Its sectional form and consequent divisibility enable it to be coupled up in any shape to adapt it to space otherwise unavailable.

Constructively the condenser consists of a double rank of vertical pipes connected by return bends at the top, and opening into a special header which forms their base. This header is laterally divided between each pair of pipes by a vertical partition extending from the top nearly to the bottom. The accumulation of liquid ammonia in the header forms a seal, compelling the gas to traverse the pipes successively, and alternately upward and downward. Water is supplied at the top of each pipe through a collar funnel surrounding it. Instead of wastefully dashing from pipe to pipe, as with horizontal coils, the water slowly creeps down each vertical pipe in the form

AMMONIA CONDENSER COMPLETE

of a thin film, without any loss from spattering. This in itself is a source of great economy in the use of water, but further than this it is found that the thin film of water is partially evaporated, and its capacity for latent heat thereby utilized. The whole condenser is generally placed in a casing open at the top and bottom, so that its warmth produces an up-draft which removes the vapor as fast as formed, and greatly promotes the evaporation and consequent cooling action of the water. It is found in practice that it is quite possible to so regulate the water that it is completely evaporated before reaching the bottom of the pipes so that the base header may be left dry. This would represent the maximum efficiency so far as concerns the use of water. Indeed we cite one instance where the condenser was successfully operated for twelve hours by means of an air-draft caused by a suction fan without the use of any water at all, except the natural moisture of the atmosphere, and this with $1,000 worth of meat depending upon it. The economy in the use of water by this condenser is not a trifling amount, but on the contrary is a very large saving, not easily stated on account of the indefinite performance of other condensers, but probably representing a saving of one-half to two-thirds of the water ordinarily required.



ARTIFICIAL ICE FACTORY.

THE MANUFACTURE OF ARTIFICIAL ICE.

THE manufacture of artificial ice naturally had its origin in warm climates, but is extending itself with a rapidity hardly anticipated into the northern states, not excepting the colder regions of New England. This is probably due to the superior quality of the product.

In the densely populated manufacturing districts the natural sources of ice supply are so rapidly deteriorating that the sanitary question has already been made a subject of legislative action. In many districts the harvesting of local ice is already prohibited. This is a condition of affairs which will get worse and not better from year to year. Many municipal governments are now compelling an inspection of ice under chemical analysis, and with other restrictions as to locality of the harvest. The necessary outcome of public feeling on this matter is that ultimately ice must be brought long distances from comparatively pure sources of supply, or made artificially on the spot. Off from lines of water communication the cost of remote supply is greatly increased. Furthermore, nothing is more certain than the periodic failure of the natural ice crop.

These points have been freely argued, not without bitterness, by the opposed interests, and we shall not re-open the question here. It is a problem which must necessarily work itself out, and no amount of forcing on the part of manufacturers of ice-making machinery will have more than a temporary effect.

A very important factor in the problem comes in from the standpoint of the investor. A strong market for artificial ice no doubt exists at this moment. If the investor can manufacture at a fair profit, the two conditions necessary to success are fulfilled, and apparently without successful competition from the natural product. Drawing upon our own experience as business men, accustomed to manufacturing, and to dealing with questions of profit and loss, we have given the subject of the manufacture of artificial ice as an investment much attention, and are satisfied that under normal business management the enterprise is stable and legitimate, and should commend itself to anyone as a business, irrespective of considerations of public spirit. But this side of the question also is proving itself with sufficient rapidity, and our purpose here is merely to call the attention of the reader to its soundness.

It should be understood once for all, that the machinery, that is to say, the compressor and condenser, have practically nothing to do with the *quality* of artificial ice. Any compressor that has a certain piston displacement, with a corresponding condenser and tank capacity, will make a tonnage of ice in proportion to that capacity, and there its responsibility ends. The merchantable quality of that ice depends principally upon the preparation of the water from which it is frozen, being otherwise affected only by the rapidity of the freezing.

The purchaser of artificial ice seeks above all things ice which is clear and colorless to the eye. The presence of air in the form of minute bubbles makes the ice more or

less "white" so called, and this the user assumes to be an evidence of impurity, whereas it is strictly an optical effect due to the reflection of light from the minute air bubbles. He nevertheless unhesitatingly accepts a greater quantity of air, often with other more or less objectionable matter, in the natural ice without question. Such is the force of habit.

As a matter of fact artificial ice is made from distilled, reboiled and doubly filtered water, and the presence or absence of air is wholly meaningless as regards its purity. But the public demand is for "clear ice" as well as pure ice and hence a system of apparatus for water treatment.

Essentially the same lines are followed by all builders, consisting in general of distillation and condensation, followed by reboiling to get rid of the air, subsequent cooling and copious filtering through charcoal. The failures in artificial ice are largely due to systems insufficient in this particular, in spite of the fact that the production of a sweet, clear and altogether satisfactory quality of ice is always within the control of the engineer, subject only to the proper operation on the part of the owner.

Again, too much has been done in the way of cheap apparatus for water preparation in the past to the injury of all concerned. We have abandoned once for all the flimsy galvanized iron soldered work which is usually made to serve for this purpose, and in place of it we build a substantial steel apparatus of carefully considered design, and as good in workmanship and material as every engineering construction should be. We invite comparison of our work in this important particular.

ARTIFICIAL REFRIGERATION.

ARTIFICIAL refrigeration is a simpler problem than ice-making to the extent that it is freed at once from the question of water treatment. The good judgment of the engineer is mostly necessary in forming an estimate of the refrigerating capacity necessary for a given space and character of service. This question settled, the mechanical requirements are easily and simply met. As stated elsewhere we look for a large field in this particular direction, and especially among a class of customers who have hitherto been debarred from artificial refrigeration by the great relative cost of apparatus of small and medium capacities.

We manufacture a line of compressors beginning with one-half ton of refrigeration, (*i. e.*, refrigeration equal to the melting of one-half ton of ice per day), and ranging up to a capacity of 60 tons per day. Any size may be driven either by general power, a direct-belted engine or an electric motor. In carrying out our convictions on sub-division of units we shall give the preference to two or more compressors aggregating the required capacity, rather than to a single equivalent machine.

Not only is artificial refrigeration cheaper—and in most cases, very much cheaper—than the use of natural ice, but it gives that which cannot be obtained in any other way—a dry, pure atmosphere. The dampness inevitable with the use of ice is entirely absent, making it possible to preserve many goods that moisture would speedily ruin, and to preserve all goods much sweeter and for a longer time.

Hygienic purity is not to be overlooked, and this can only be secured by mechanical refrigeration. Natural ice, especially for cooling purposes, is often harvested from impure ponds or canals, etc., so that when it melts it necessarily fouls the air or leaves a deposit of filth behind it. The foul air impregnates and rots all the wood with which it comes in contact, weakens floors and joists, and contaminates many classes of goods in storage.

The proper refrigeration of meats and produce is a matter which receives far less attention than its importance deserves. It is safe to say that it is not possible to properly preserve meats, game or poultry in the same room with melting ice. The moisture-laden air soon becomes thoroughly impregnated with the volatile products of the provisions stored, and in time takes on the smell of rancid oil, which can easily be detected on entering the store-rooms. This rancid vapor is an excellent medium for the generation of disease germs, and results in the inevitable contamination of the merchandise among which it circulates. In artificial refrigeration, however, all vapor, pure or otherwise, is taken from the air and deposited upon the chilled surfaces of the pipes, where the temperature is so low that the noxious germs, if present, are powerless for evil. The air of such a store-room is sweet and dry, much resembling that of the high table lands of the West, where meat will desiccate without decay in the open air, owing to the absence of moisture.

Perfect control of temperature is possible only with mechanical refrigeration. Sudden transitions from moderately warm to excessively hot weather, and *vice versa*, it is well known, injure some classes of merchandise more than a steady temperature

many degrees higher. By artificial refrigeration, these conditions are at all times under control.

The saving in space by the removal of ice-boxes is often a large increase in the earning capacity of a plant. We cite one packing house, in which out of 16,000 cubic feet of space, over 4,000 cubic feet were occupied by the ice-box. This was replaced by a 3-ton refrigerating machine, thereby adding 33 per cent. to the available cellar room, and enlarging the earning capacity nearly 50 per cent.

The field of application for artificial refrigeration is endless, assuming an apparatus which can be sold at a reasonable price and operated by ordinary labor. We invite correspondence from Markets, Creameries, Soap Factories, Refineries, Chemical Works, Wine Cellars, Confectioneries, Freight or Passenger Steamers, Hotels, Hospitals, Apartment Houses, Safe-deposit Companies (for storage of furs) and similar industries in which artificial refrigeration has not thus far been available. Cold-storage Warehouses, Breweries, Packing Houses, etc., already depend wholly upon artificial refrigeration, and trade in this direction need not be especially stimulated.